

Deliverable Acceptance Form

Date: 4/20/05

PROJECT IDENTIFICATION

Project Name: STAGEnet Infrastructure Services

Project Sponsor(s): Jerry Fossum

Project Manager: Dirk Huggett

DELIVERABLE INFORMATION

Project Phase: Phase 1

Deliverable Name: Final Vision Document

Author: Federal Engineering

ACCEPTANCE CRITERIA

Criteria:

This is the final report that portrays the basic vision of where ITD would like to see STAGEnet in 5-7 years. The intent is to use it as the baseline when speaking with the focus groups and vendor meetings. The report should contain an executive summary, some high level benefits expected to be delivered by the project, and a fairly high level picture of what the network would entail. It would also describe some of the key technologies being considered.

Accept / **Reject (If rejected, provide reasons below)**

Signature:  Date: 4-20-05

Jerry Fossum, Telecommunications Director

Attachments: Final Vision Document

STAGENet Vision Statement

Final Report Version 2.0

April 18, 2005

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STAGENet 2006 Vision Statement

1.1 EXECUTIVE SUMMARY

This document provides a recommended vision statement as the baseline for defining North Dakota's telecommunications network over the next 7-10 years. The vision will support a high level procurement and development strategy for future voice, data, and video services (excluding radio communications), and address the goals of achieving a) increased bandwidth, b) low network latency, c) reliable and survivable service, d) security and privacy, e) wireless connectivity, and f) low-cost access.

Working in concert with the Information Technology Department (ITD), Federal Engineering (*FE*) reviewed existing network systems, and reviewed feedback from ITD meetings with key state management officials, to develop, refine, and document the vision statement. This report outlines current conditions and recommends a future migration path.

The current telecommunications network infrastructure for the State of North Dakota is a shared enterprise infrastructure called Statewide Technology Access for Government and Education Network (STAGENet). It is managed and operated by the Information Technology Department (ITD). STAGENet infrastructure provides statewide network access and connectivity for:

- ✓ State government
- ✓ State, local, county, and city offices
- ✓ K-12 schools
- ✓ Universities (public and private)
- ✓ Colleges (including tribal)
- ✓ Public libraries
- ✓ Telecommunications providers
- ✓ Health Alert Network

STAGENet 2006 is the next generation network that envisions a cost-effective and reliable infrastructure to both meet and surpass current business objectives and also provide the scale and flexibility to support the convergence of voice, video and data technologies, as key components in optimizing statewide services.

The current infrastructure, operational for over 4 years, is now experiencing significant demands for additional bandwidth, lower network latency, and higher quality of service resulting from introduction of the following requirements:

- Document imaging
- Geographical Information Systems (GIS)
- Increased research at State universities and colleges



- Increased use of video throughout all State educational institutions as well as a number of government functions
- Online access to government and education services throughout the State

Originally deployed over an Asynchronous Transfer Mode (ATM) infrastructure, STAGENet has evolved into a hybrid network in order to meet increased demand. The infrastructure now includes the use of optical fiber, Internet Service Provider (ISP) broadband services, and wireless/satellite connectivity. (Some fiber infrastructure is operated through private consortia that provide feature support while ITD provides the overall network support.)

An increasing number of mission-critical government business functions require higher levels of security, redundancy, availability, and reliability. These include:

- ✓ Homeland Security initiatives
- ✓ IT system upgrades and migrations
- ✓ North Dakota banking system upgrades
- ✓ State disaster recovery models

Just as critical is the need to provide physical separation of portions of the network in order to mitigate propagation (due to worms/viruses) and network failure risks. Additionally, there are increasing network requirements for applications like the Highway Patrol's Case Management System, DOT's Commercial Vehicle Systems and Networks (CVISN), the Division of Emergency Management's Computer Aided Dispatch (CAD) system, and the Division of Health Services' Direct Services Provision for Mental Health Services video application.

Other leading-edge applications require planning for bandwidth, reliability, security, and connectivity considerations. These include:

- ConnectND – A joint initiative between state government and the North Dakota University System (NDUS) that provides state-of-the-art integrated software systems to enhance service to the state's students, employees, and other constituents.
- Interactive Video Network (IVN) – A statewide resource that provides students with face-to-face education from almost anywhere, improving the richness and quality of education to all regions of the state.

While these and other state requirements generally rely on wireline technology, there is also a rapidly growing demand for mobile (wireless) communications. Public safety, law enforcement, transportation, highway maintenance, and consumer activity management, to name just a few, are moving toward wireless interactions more quickly than expected. In the blink of an eye, the wireless environment is transcending nearly every statewide activity and ITD must enhance its wireless networks to meet new demands for anytime/anywhere connectivity to the STAGENet infrastructure.



Looking toward the future, any proposed network must meet ITD's goals for cost-effective infrastructure, feature-richness, and innovative networking technologies across the public safety and business landscape. To accomplish this, STAGENet 2006 must enable the State to provide new and enhanced value-added services quickly and efficiently, and at the same time provide incentive for commercial investment in the State of North Dakota. The following are key attributes that must be present for STAGENet 2006 to meet the growing requirements. They are:

- Potential for design growth and/or modification without technology refresh
- Ability to scale services and offerings up or down depending on selection criteria
- Physical separation for state and local government, K-12 schools, North Dakota University System (NDUS), and Interactive Video Network (IVN)
- Control over provisioning and configuration changes, including moves/adds/changes/disconnects (MACDs)
- Sourcing for partnerships, alliances, in-source needs, etc.
- New, leading-edge equipment or facilities as an investment in the State of North Dakota by service providers

1.2 SCOPE DESCRIPTION

Current. The current network infrastructure is a dual hub/spoke design with network nodes in Bismarck and Fargo. These nodes are interconnected by multiple OC-3s and provide redundancy for all high-level applications. There is a Tier-1 ISP OC-12 connection at both locations providing diversity and redundancy for Internet access. State and local government business functions, the NDUS, political subdivisions (county courthouses and city functions), K-12 schools, state tribal colleges and private institutions, and the Interactive Video Network are all duplicated in each node.

Future. ITD plans to transform the current network into next generation capabilities through a self-healing ring topology, and at the same time expand the backbone from 2 network nodes to a minimum of 4 (including Minot and Grand Forks).

The most desired configuration, however, would include as many as 8 network nodes providing first level backbone access to most of the cities housing State universities and colleges. This would include network nodes at Jamestown, Devil's Lake, Williston, and Dickinson, while providing the ability for high-speed tail circuits to Wahpeton, Mayville, Valley City, and Bottineau to complete the high-speed connectivity throughout the university system. (Both Mayville and Valley City are potential additions to the backbone design since they are located along the existing fiber infrastructure.) The expanded backbone must be a technology-enabling platform, allowing for growth of current applications, like IVN and ConnectND, as well as providing service connectivity enhancements without network re-design.



The ultimate goal would be to provide an 8-node, metro-fiber backbone at 1 – 10 Gigabit Ethernet speeds.

ITD should pursue a cross-connection for each network node at the service provider's facility to provide wire-speed data transfer at the backbone level. By expanding the backbone to 4 – 8 nodes, ITD would be able to provide higher speed services over a larger region of the state. The upsides are 1) the enhancement of the network disaster recovery model (through a redundancy and diversity architecture), and 2) the inclusion of high-speed connections at redundant locations to support the growing DSL/cable, wireless, and satellite connectivity requirements. This would provide additional (and similar) network services to all stakeholders and constituents.

Table 1 below provides the high-level benefits for STAGENet 2006:

| | |
|--|---|
| <p>Benefits to the State of North Dakota Resulting from the STAGENet 2006 Initiative</p> | <ul style="list-style-type: none"> ▪ Introduce fiber access to more of the major centers within the State ▪ Grant NDUS Broadband bandwidth to support the introduction of leading-edge applications and allow for unlimited internet access ▪ Provide redundant connectivity and fail-over within the backbone while expanding the State's disaster recovery model ▪ Establish a performance analysis and measurement system ▪ Establish formal service levels across the entire STAGENet 2006 infrastructure ▪ Enable both physical and high-speed virtual network segmentation ▪ Provide a single, cost effective network to leverage economies of scale and enable the convergence of voice, video, and data ▪ Enable statewide high-speed access through diverse technologies, such as DSL/cable, wireless and satellite ▪ Allow for more consolidation of LAN infrastructure throughout K-12 system in coordination with Joint Power Agreements (JPA) |
|--|---|

Table 1 – Benefits of STAGENet 2006

1.2.1 BACKBONE

STAGENet 2006

The characteristics include two independent rings in a self-healing configuration (see Figure 1 below). This network is designed to traverse 8 network nodes along existing fiber infrastructure providing 7x24x365 availability. Both the current, and anticipated future demand for additional bandwidth, and the requirements for low network latency, high reliability and high quality of service from the IVN, are critical drivers toward an optical fiber infrastructure. Coupled with a strategy for IP convergence to enable voice, video, and data services on a single network infrastructure, the 8-node fiber architecture will be paramount to meeting statewide demand in the future.

This next generation network must also facilitate an expanded disaster recovery model, fail-over strategy between network nodes, and network traffic control in order to meet the growing demand for high-end applications and maintain a leading edge technology infrastructure. Additionally, this new infrastructure will be necessary to support the expansion of additional technologies such as wireless and satellite, and to provide direct high-speed access throughout as much of the state as possible. STAGENet 2006 should provide connection to redundant wireless and satellite nodes enabling “always on” connectivity to the most remote locations in the state.

In order to meet these performance and reliability requirements, ITD should look for consistency of throughput and diversity in route selection throughout the provider network, maintaining the integrity of STAGENet 2006. A strategic goal would be the leveraging of existing fiber infrastructure and current hardware everywhere possible.

Required functionality will include control over provisioning, with the ability to quickly and efficiently work with the provider to lessen lead times and allow for the configuration of network nodes by ITD professionals. With the self-healing characteristic of the network and gigabit speeds over fiber, ITD should expect virtually unlimited bandwidth, allowing for on-demand provisioning. This will support business partner requirements for a high-availability, scalable, and reliable infrastructure for:

- Voice, video and data convergence
- Enhancements to ConnectND and IVN
- Increased performance requirements from State functions such as the DOT, DHS, Game and Fish, etc.
- Increased demand for bandwidth and class of service by the North Dakota University System
- E-government strategies such as private practitioner’s portal, ShopND website, online grants software, and online campground reservation system
- Expansion of state services to all constituents



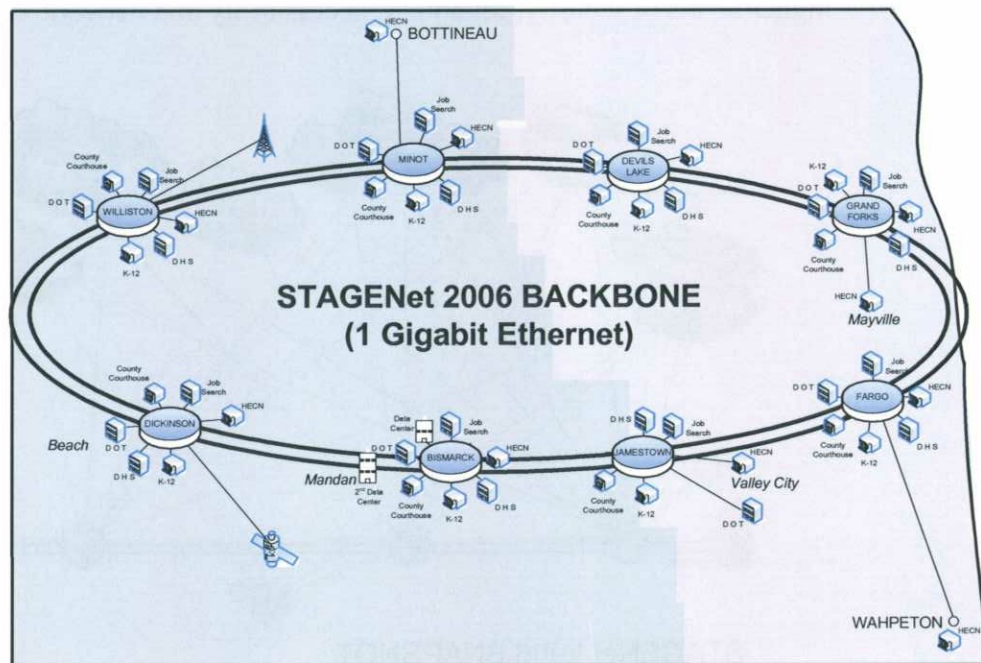


Figure 1 – STAGENet 2006 Conceptual Backbone Drawing

1.2.2 NETWORK ACCESS

1.2.2.1 Wireline Networking

Current. Approximately 470 K-12 schools throughout the state have network access to the ATM infrastructure via T-1 or DS3 connectivity. Federally funded by the e-Rate program, which provides a statewide flat rate pricing structure, K-12 schools are provided a service by the current provider inclusive of the transport and router. ITD manages and operates the equipment at each of the sites while the provider maintains the asset and manages the circuit.

Future. ITD should explore a tiered rate pricing structure allowing for better pricing at the state's larger municipalities. County courthouses (which are part of the political subdivision) and state/local government agencies (such as the DOT, Job Services and the Department of Health Services) also require statewide access to STAGENet. Connectivity requirements have also increased with the need to connect a larger number of DSL/cable remote offices as well as the planned statewide wireless/satellite network expansion as part of STAGENet 2006.

Once the high-speed backbone is connected, each network node would have a hub/spoke topology providing network access to geographically strategic sites statewide. With the configuration of VLANs for each of the business units, STAGENet 2006 would successfully deliver physical separation and virtual segmentation for state/local government, NDUS, K-12 and IVN. The outcome would be a cost effective and highly available network telecommunications

infrastructure. This network design (Figure 2 below) achieves the requirements for higher levels of security, reliability, accessibility and network management.

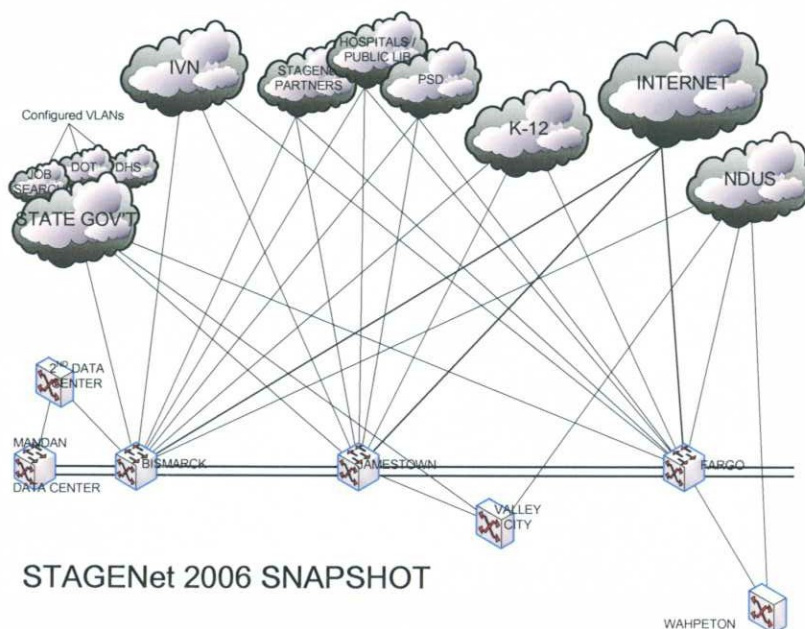


Figure 2 – Three-Node Snapshot of STAGENet 2006

The current configuration of 1mb reserved for video has reached capacity at a large number of the T-1 connected schools and must be upgraded to higher speeds to accomplish strategies for:

- ✓ State education technology initiatives focused on improving distance learning and independent study capabilities.
- ✓ New connectivity and research opportunities for students and teachers.
- ✓ Continuing the large-scale implementation of PowerSchool, the student information system will be available to every school district in the state.
- ✓ The expansion of video curriculum throughout the state providing face-to-face learning opportunity to all of the approximately 210 school districts statewide.
- ✓ Support the increased requirement for desktop video throughout the university, college and K-12 systems.
- ✓ K-12 school requirements for flexible and scalable network connectivity for the online planning tools and data systems that will enable teachers and administrators to more effectively and efficiently track student progress in an effort toward learning improvement.

- ✓ Create the potential for consolidation of LAN infrastructure and required support into a central location per school district thereby enabling economies of scale and optimized expertise.
- ✓ Allow for the isolation of test labs throughout the state's university system.

Voice, video, and data convergence will increase the requirement for additional capacity, higher reliability, and quality of service. For any site statewide, IP convergence will be a critical factor in the future, as both voice and video will share the STAGENet 2006 infrastructure.

ConnectND and IVN are two of the many applications driving high-availability, security, and redundancy requirements. ConnectND is the state-of-the-art Enterprise Resource Planning (ERP) system. This ERP is the joint effort between the NDUS and state government that runs the computer functions for NDUS academic and administrative areas, including student administration on campuses, financial and human resource applications throughout the university system, and financial and human resource functions for the state/local government. ConnectND benefits employees, customers, and constituency groups of the North Dakota University System and the State of North Dakota.

The IVN provides a system of geographically diverse consortia that, in partnership with ITD and local telecommunications providers have developed their own high-availability network over dark fiber with connectivity to STAGENet. The STAGENet infrastructure provides the facilities and bridging for this statewide video network, while support comes from the number of consortia throughout the state. Some of the consortia are SPICE, SEND, Great Western, and Red River ITV.

There are approximately 260 video classrooms currently configured with 1mb reserved for video at K-12 schools with T-1 access. There is a close working relationship between higher education administrators, the different consortia and ITD. This relationship should support any future expansion and/or upgrade in order to provide the most benefit to the State of North Dakota.

There are also a number of other important applications with increased connectivity and bandwidth requirements. These include the Criminal Justice Information System (CJIS), IVR, ND GIS Hub, Email, Database, and Mainframe applications (i.e. Drivers Licenses, demographics).

1.2.2.2

Wireless Networking

Current. The current STAGENet infrastructure includes a small number of sites connected by both wireless and satellite technologies. A number of state and local government agencies are currently using a broad range of wireless solutions to support an increasing number of mobility requirements. Highway Patrol, the Bureau of Criminal Investigation (BCI), as well as the Departments of Health Services and Transportation are all agencies that currently have high mobility requirements.

In order to support the Highway Patrol's Mobile Data Communications System (MDCS), NDDOT's Roadway Weather Information System (RWIS) and the



statewide 511 system, BCI's increased need for mobility in the field, and DHS' Direct Services Provision video application, these agencies require real-time access to critical information 7x24x365 from anywhere in the state.

The MDCS application enables law enforcement to increase productivity by increasing an officer's time in the field versus time in an office. It also provides real-time access to critical information and increases efficiency and safety, by capturing data at the patrol car level. BCI has a need for both mobility and access from anywhere in the state. Rapid deployment and redeployment of field officers requires high-speed access for real-time transfer of incident/event information.

The DHS has a number of applications requiring increased mobility including Eligibility Determination and Direct Services Provision for Mental Health Services applications. Increased bandwidth requirements also exist to satisfy HPPA requirements, delivering attachments (i.e. MRIs and X-rays) with claims.

The NDDOT also has a number of applications, including the Roadway Weather Information System (RWIS), the Auto Traffic Reporting (ATR), and the statewide 511 system that provide the people of North Dakota real-time weather and traffic information, load restrictions, road conditions and construction updates on the state's highways just by accessing their wireless device. Weight in Motion (WIM) is another DOT application used in various rural areas to calculate a truck's weight, axle width and speed by using devices buried under roadways. This information needs to be relayed in real-time to patrol cars in the area. The current deployment of the new Radio system to the existing tower infrastructure allows for connectivity, but at slow speeds (typically less than 19.2Kbps). Increased speeds would enhance the operational capabilities of all applications including the download of web information, crash reports, etc.

The North Dakota University System's goals of anytime/anywhere connectivity and low-cost network access are not only critical to the eleven campus locations and their immediate communities, but also to rural and small communities. Requirements for the latter areas include applications such as Ag Extension which has connectivity requirements with the research extension centers (RECs), and the UND Medical School's video conferencing needs which encompass instructional and research activities across medical facility regions throughout North Dakota and surrounding states.

Future. With the ever-increasing size of today's mobile workforce, it is expected that both wireless, and to a lesser degree satellite, will become key components of STAGENet 2006 and enable network access to the most rural and regional locations. Also, increased wireless capability will give North Dakota an efficient communications tool for an increasingly mobile workforce anywhere in the state. Access to information faster and in real-time and the resultant increase in data accuracy and productivity are just some of the benefits of a more expansive wireless network, particularly enabling law enforcement to increase productivity and officer safety.

The desired wireless solution would provide broadband bandwidth, VPN capability and statewide coverage for numerous services to the many different types of devices



in the field, regardless of time or location. STAGENet 2006 should have the ability to offer increased statewide capacities for a larger constituency, as well as positioning North Dakota as a national leader in state communications technology.

ITD should leverage existing infrastructure in both technologies to provide, at minimum, “hotspot” services in order to enhance service capabilities and bring network access to as many, if not all of the 210 communities statewide. As part of the wireless initiative, ITD is also re-evaluating the current support for cellular telephones throughout the state and local government agencies. ITD envisions this statewide wireless network through partnerships or consortia, with strategically placed network access points (NAPs) on the STAGENet 2006 high-speed backbone.

1.2.3 INTERNET ACCESS

Current. Internet services are currently provided by two independent, and dedicated OC-12 circuits directly connected to an internet Tier 1 provider. This configuration provides for diversity and supports BGP, IPv6, I1, and I2 services.

Future. With increased use of statewide internet access, particularly within the NDUS, it is essential that STAGENet’s infrastructure continue to provide Tier 1 fiber access at increasing access rates. Among the services most desired are:

- Network end-point expansions and growth
- Network core expansions and capacity growth
- Enterprise VPN solutions
- Remote access options
- Increasing demand for QoS for voice and video applications
- Rural and local wireless access solutions

1.3 KEY TECHNOLOGY AND FEATURES

The following are technologies that are being explored for viability in meeting the STAGENet 2006 Telecommunications Refresh project requirements. Figure 3 shows the connections at the node-level.

1.3.1 TECHNOLOGY

Lightwave technology, such as Lambda, would offer virtually unlimited bandwidth while providing the most scalable and flexible self-healing backbone. This technology could be a prime incentive for commercial investment in the state and could be an attraction for top-level researchers at both NDSU and UND.

OC-X technology is widely used today and this technology has the ability to configure 802.17 RPR. ITD needs the flexibility to provision bandwidth to suit requirements and should pursue clear channel throughout the backbone.

Optical fiber infrastructures have been developed throughout the state. Access to Dark Fiber for purposes of leasing is a strategy that ITD could pursue.

Wireless broadband, using either cellular or satellite services for statewide government and consumer use, or a “hotspot” service as an alternative, would



provide service for major centers throughout the state. Wireless “canopies” have received support from state and local government. Other options being evaluated are 802.11x, EvDO, and WiMax. ITD is interested in finding out whether there may be opportunity to create a partnership, or consortium-type arrangement with multiple providers.

DSL/cable is currently used to provide low-cost broadband to as many of the state’s agencies’ remote locations as possible. This is used mainly for small remote offices, but also for telecommuting from home offices.

Even though **satellite access** has a maximum bandwidth of 128k, this technology is an asset that could be used to augment, or backup, key remote locations throughout the state. The DOT currently uses weather stations in very remote locations for highway alerts, road conditions, changing weather patterns, etc.

Figure 3 below shows a high-level detail of the connections at the node level.

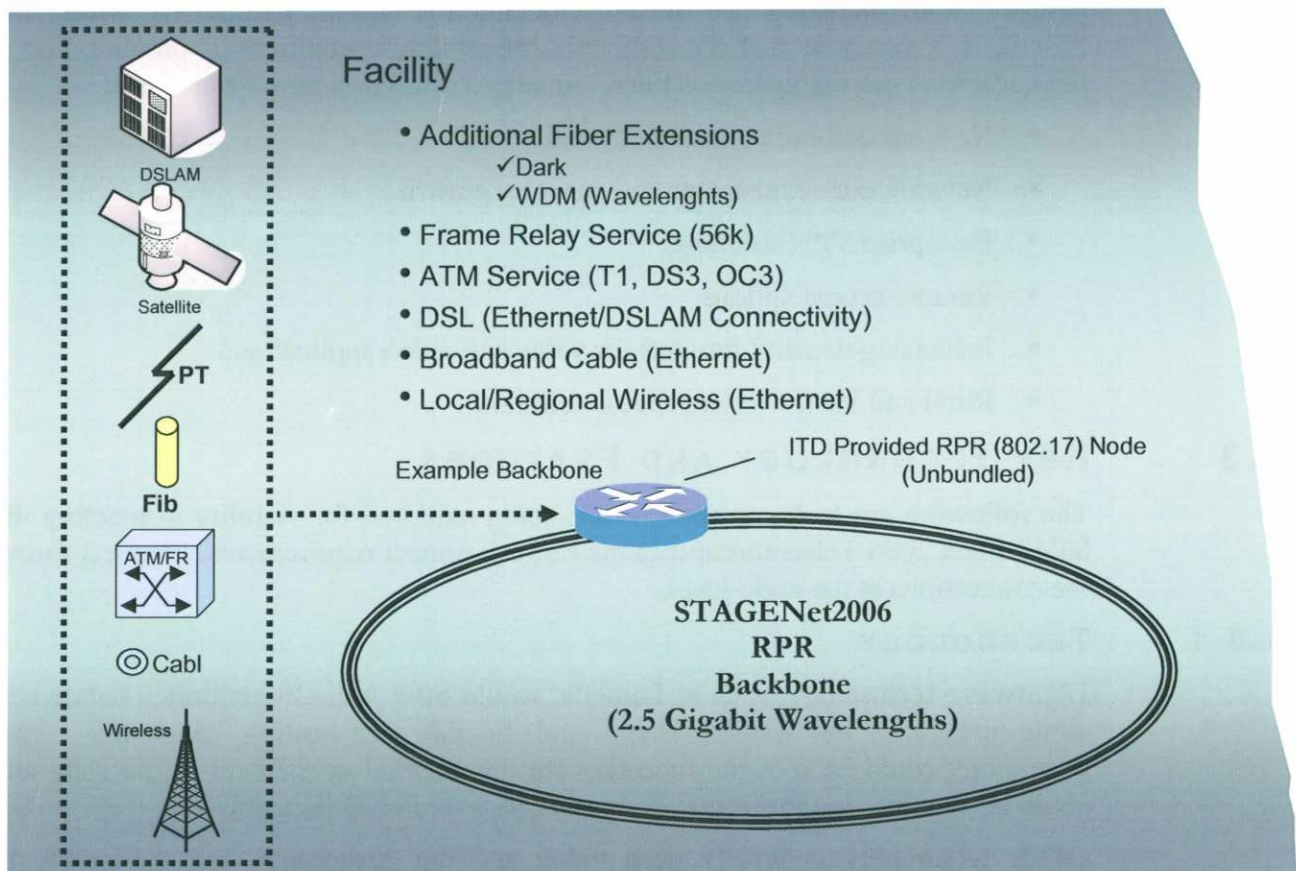


Figure 3 – STAGENet 2006 Node level diagram

1.3.2 FEATURES

Bandwidth – Applications such as video, ConnectND, and others are starting to require large amounts of bandwidth. STAGENet 2006 needs to have the ability to provide bandwidth on demand.

Quality of Service (QoS) – Increased use of video applications and IP convergence are but two of the applications requiring QoS. The future network environment will require network traffic prioritization.

Virtual Private Networks (VPNs) – VPNs are essential in today's networking environment and preferred for logical separation of networks.

Virtual Local Area Networks (VLANs) – VLANs are a preferred method of configuring logical separation and providing added security for diverse functions. VLANs for DOT, DHS, JS, K-12, HECN, Law Enforcement, and county courthouses are desired today.

Accessibility – It will be essential to understand the provider's network and how diversity and the delivery of bandwidth will be guaranteed, not only within the STAGENet infrastructure, but also within the service provider's network. The preferred approach is for the provider network to deliver service for STAGENet from locations within the state, preferably within the Bismarck and/or Fargo areas, or in one or more of the established network nodes providing diversity throughout the backbone.

Manageability – Manageability defines the capabilities for applying additional and/or modified security configurations on an as needed basis, as well as performance reports and root cause analysis.

Scalability – The state should have the ability to provision bandwidth on demand, with guarantees of availability and optimal route selection within the provider network.

Security – Physical separation of 4 main network users: state/local Government; North Dakota University System (NDUS); Interactive Video Network (IVN); K-12.

Reliability – Latency is a major issue with new applications. QoS will need to be configured throughout the entire network, not just on the Video Network.



